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THE OUTLOOK FOR AGRICULTURAL RESEARCH

AT the close of the World War, the outlook for research in the United States, both as to its immediate future and as to its permanent place in our economic structure, was very rosy. The tremendous part which the results of new discoveries played in the conduct of the war and in the sustenance of the nations whose normal productive energies were being diverted to war purposes, had attracted popular attention to and support of research activities. Research men had received new impetus and enthusiasm from the practical benefits of their work which became suddenly manifest. Organization of research agencies and the general recognition of the possibilities of cooperative organized attack upon the problems which need scientific study seemed to promise much for the immediate future of research work.

All this seemed to be particularly true of research in agriculture. The vital importance of the products of agriculture to the national need had been emphasized again by the war-time needs and slogans. Nations, like ours, which had been going through a period of almost inconceivable industrial development had come to hold in light esteem the earlier understanding of the importance of a sound and permanent agricultural system, which knowledge had been forced upon the preceding generation of American statesmen by the post-Civil-War experiences. But the vital importance of a steady production of a sufficient supply of agricultural products for the world's needs had been so emphasized by the war, and America's strategic position as a food-producing nation had been so clearly shown, that it seemed that a re-awakening of public interest in the support of anything which would aid in insuring a sound national agricultural policy was inevitable.

Now, however, the expected *renaissance* in agricultural research seems to have been temporarily thwarted by the business depression and by the general clamor against increased expenditures of public funds for any purpose. I believe that this condition is only a temporary one. We are going through an experience which brings a blush of shame to the cheek of every loyal American. We are seeing every principle of patriotism and devotion to public welfare which were such powerful stimulants to individual and national effort during the war submerged by the petty political jealousies.

These are reconstruction days. War-time fever has only just left the body politic. Physical power, mental acumen, and spiritual force seem to be still at a low ebb. No true American patriot believes that these are manifestations of sound, normal American life. And every true American, embued with the characteristic hopeful American spirit, looks forward with optimistic confidence to a speedy recovery of sound body and sound mind in our national existence.

Hence, we ought not to be discouraged or dismayed by the present temporary reaction in popular enthusiasm for our research work. This lack of enthusiasm ought not to be mistaken by us to be any definite or permanent opposition to agricultural research. The lessons of the war-time emergency concerning the importance of agriculture to the national life are too clear and too convincing to be easily forgotten. Indeed, it is the plain duty of those of us who, by our engagement in public service for agricultural development, have a unique opportunity to shape public opinion and to mold public sentiment, to see to it that this important lesson is not forgotten and that the proper place of agricultural research in relation to sound agricultural development continues to be kept clearly in mind.

The fundamental place of agricultural research in any system of agricultural education and development is so apparent that it needs no elaborate discussion or argument concerning it. It is an old and trite saying that "no stream can rise higher than its source." And it is a self-evident fact that the source of agricultural knowledge is careful scientific investigation of the laws of nature.

This was clearly recognized by the earlier leaders in agriculture who, soon after the establishment of the Land-Grant Colleges began the investigational work which soon led the way to the establishment of the agricultural experiment stations as definitely organized agencies for agricultural research work. In most of the States these stations were organized as a unit of the college and under the administrative supervision of the same officers who administered the teaching functions of the institutions. In a few states there were organized experiment stations which were entirely separated in their administration, functions, and activities from the teaching service. But in most cases the research work was closely associated with the teaching duties of the faculty of the agricultural college, and in about one-half of the states the college itself is an integral part of the state university with its graduate school, which also has general research possibilities.

The need for post-graduate training for teaching, research, and extension workers in agriculture has resulted in the development of graduate schools in many of the separately organized land-grant colleges. Thus it has come about that in most of the states there are two agencies or units of the land-grant colleges, which are to be considered as potential sources for agricultural research work; namely, the experiment station and the graduate school.

In any consideration of the future possibilities for agricultural research, therefore, we ought to count upon the development of these two types of agencies. The growth of these two, side by side, in the same institutions has often led to a confusion of their functions and possibilities, which may be wholly unconscious and unintentional in the minds of the members of the staff and administrative officers of these combined institutions; but which is quite apparent to those

of us who are connected with the separate research institutions. It is, perhaps, because of my recent change from one type of these institutions to the other that the inevitable distinctions between graduate school research work in agriculture and agricultural experiment station research work have forced themselves upon me. They now appear to me to be so significant as to justify my commenting upon them in the hope of at least partially clarifying the situation and so affording a better basis for future development of all of the possibilities of agricultural research work.

The questions at issue may be more clearly indicated if formulated into two definite queries, the reply to the first of which is necessarily dependent upon the answer to the second. These questions are: "Is the maintenance of an experiment station as a separate unit of the land-grant college desirable?" and "How does an experiment station differ in its methods and accomplishments from other agencies for research, such as the graduate school, or the personal research work of an academic faculty?"

Turning first to the second of these questions, namely, "How does an experiment station differ from other agencies for research?" my answer is that it differs in the environment or atmosphere which it creates. Its atmosphere is that of research for the accomplishment of definite economic progress; while that of the graduate school is chiefly research for training of graduate students in the method of critical investigation, and that of individual research work is the promotion of individual professional standing and welfare. Now, I recognize many exceptions which might be taken to such a generalization when applied to the cases of brilliant individual research workers in these different organizations. But I am discussing now the environmental conditions of the organized entities or institutions known respectively as experiment stations, graduate schools, or university faculties.

As between the research work done at an experiment station and that done at a graduate school, both parts of the same land-grant college for example, the physical materials worked with may be the same and the final results of the investigation of any given problem by either agency ought to be the same, provided the ultimate truth of the matter is reached; but the environment under which the investigators will work is essentially different. In both organizations there may be less mature and less experienced investigators working under the inspiration and guidance of older and more experienced research men; but in the graduate school the immediate object to be attained is the completion of the work in such a way that it can be formulated into and defended before a group of examiners as a thesis; while in the station, the investigation is to eventuate in some contribution to agricultural science or practise which must stand the test of practical application in farm management operations. It is possible that the methods and mental attitude of the leader of the work toward its ultimate outcome may be identical in each case; but that of his assistants will most certainly be different, and the leader himself is almost super-human if he is not influenced by the desire to see his students present "a good thesis" as the result of the work. But the more essential differences lie in the undivided interest in and devotion to research problems which is, or at least ought to be, characteristic of the experiment station. Faculty men necessarily have to be interested in class-room problems and in the preparation of the results of their research in forms which are pedagogically sound and academically attractive. Graduate students are usually taking course work in addition to thesis work and are likely to have their interest in their investigations diverted from the main issue, or their observations influenced by their coordination or contrast with class-room ideas. I am not arguing against research work in the graduate schools. On the contrary, I regard it as the very essence, the *sine qua non*, of graduate school work. Neither would I belittle the economic value of the

results of the research work which is so well done in the graduate school.

What I am trying to point out is that there is a definite atmosphere or environment favorable to agricultural research which is provided by the experiment station organization which can not be provided by any other research agency. This being my answer to the second question propounded above, the answer to the first, namely, "Is the maintenance of a separately organized research agency known as an experiment station desirable?" must be an unqualifiedly affirmative one. I am not now discussing the question of the geographical or administrative separation of the station from the college. That is an entirely different question to be answered from entirely different considerations than those which are proper to this paper. But what I do urge is that the agricultural research work of the land-grant college, for which federal and state appropriations are given in order that the practise of agriculture may be improved and the economic welfare of the people enhanced, shall be so definitely organized into a distinct entity (having for its sole purpose the promotion of research) that the environment most favorable to successful research work may be created. I do not need to enlarge upon the details of staff conferences; of cooperative work upon the project by the proper men, regardless of administrative departments of instruction; of freedom from interruption of thought and of work by other duties; etc., which contribute to this environment favorable to a high type of agricultural research. These are familiar to you all. I do wish, however, to urge upon the director of the station, in each case, the importance of the maintenance of a definite station staff with definite assignments to it and of definite staff activities as a highly important factor in developing the atmosphere or environment which I have been attempting to describe and which I believe to be an important factor in the future success of agricultural research work.

There is an additional problem in the administration of experiment station work upon the solution of which I believe its future possibilities depend in considerable measure. I refer to the effect which may be produced upon both the character and the method of our research by the present demand for so-called "practical results" from it. An inevitable and altogether wholesome reaction from the extravagance of war-time expenditure has set in. I hope that it may continue and that no object which does not promise definite improvement in our living conditions may successfully appeal for public financial support. I agree, therefore, that our expenditure of public funds for agricultural research must have as its proper justification the accomplishment of some definite "practical result." I believe, however, that a definite contribution to science which may make our structure of agricultural knowledge more complete, more sound, or even more beautiful, is a "practical" result of research work.

I have no patience with the dilatory browsing around in the field of the unknown in hopes that something interesting to the individual browser may turn up, which is sometimes lauded as "the search for truth for truth's sake," as a guiding principle in station research. I believe that each station project should be a definitely formulated effort to solve some problem which will contribute either to our knowledge of agricultural science or to our methods of agricultural practise. It is, of course, the second of these two types of contributions which is usually meant by the phrase "practical results," and contributions to agricultural scientific knowledge are regarded by some of our constituents as of doubtful desirability. I do not intend, however, to debate this particular point at length in this paper. I have indicated my own very definite convictions concerning it.

What I do wish to discuss, however, is the possible effect upon the methods of our research work of this continual pressure upon the station administration for so-called "practical results." This pressure may be either direct, in the form of active criticism

of the station's program of work by individual or organized farmers, or it may be the indirect and insiduous influence of the ability to cite definite financial benefits to the state or nation from the result of each completed project of station work, as a matter of pride in achievement or as an influence in securing future moral and financial support for the station's program.

Whatever the character of the pressure may be, it will be most unfortunate for the ultimate success of agricultural research in America if this pressure is allowed to influence the methods by which the station research is conducted. I believe it to be a cardinal principle of station research that the investigations shall be pursued according to the very best possible methods of scientific inquiry by a staff of investigators who are as well trained in these methods as it is possible to obtain. It is, of course, fortunate for the man himself if he has had such practical experience in farm operations as will lead him to see the possible applications and ramifications of his problem and such a back-ground of experience is an undoubted aid in the selection and formulation of a project to be undertaken; but, on the other hand, it may be a real handicap if it so prejudices him against certain methods of study as to limit his working tools of investigation, or if it gives him such pronounced preconceptions as to the probable outcome of the investigation as to unconsciously warp his observations or conclusions. From the standpoint of the successful prosecution of station research an open and unbiased mind and the ability to use skillfully all the working tools which are afforded by a proper knowledge of fundamental sciences, are, in my judgment, better qualifications for station research than is any amount of practical farm experience.

I am not discussing preparation for extension or teaching of agriculture; but preparation for agricultural research. I do not wish to appear to belittle the value of practical farm experience to any worker in scientific agriculture. I know what its value has been to me. Nor do I underestimate its value in contributing to the solution of many problems which come to the station to be answered. But there are hundreds, if not thousands, of farmers in every state who have a vastly better wealth of farm experience to bring to the solution of these problems than we could possibly get for our station men. They can, should, and do contribute the part to the improvement of agricultural practises which farm experience can teach. They can not contribute what scientific inquiry has to add to agricultural knowledge and it is this latter contribution which our stations should be organized to provide.

I have every confidence that the future has even greater opportunities and successes in store for the contributions of science to agriculture than the past has had, and I, therefore, close this paper with the utterance of my profound conviction that the present apparent slight reverse is but a temporary phase of the general problem of agricultural development in America, and that the outlook is for future opportunities which will challenge and stimulate our very best efforts to meet them.

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ZOOLOGICAL RESEARCH AS A CAREER

IN the present state of the subject a person looking forward to a career in zoology must, in most cases, expect to find it in academic life. Here there are increasing opportunities leading out into special lines such as anatomy, physiology, genetics, histology, embryology, cytology, entomology, paleontology and in occasional cases into systematic work upon limited groups, such as fishes, reptiles, birds, mammals, molluscs, etc. The increased entrance requirements of professional schools, demanding scientific training, has led to larger numbers of students in the elementary zoological courses, thus making more teaching positions in colleges; while improved methods of instruction in anatomy, physiology, histology, and embryology have

opened up positions in medical faculties for trained workers in these subjects.

The history of a professor of zoology at present would run some such course as this. While an undergraduate he might show a special interest and ability in the subject leading to an appointment as assistant of some kind in the laboratory. Upon graduation he might receive a scholarship in the graduate school and later a fellowship, these various appointments making him somewhat self-supporting. Having obtained his Ph.D. degree and developed a special interest in some phase of zoology he could expect to be appointed an assistant or instructor taking part in the laboratory instruction of the elementary courses. After a time he would be given charge of a class in the particular subject in which he had specialized and with it the rank of assistant professor. After a number of years he would attain the rank of associate professor or its equivalent. Finally after a period of about fifteen years he might be made a full professor. During the preliminary years of his career his salary might range from $1,000 to $3,500 per year, while as full professor his income would be from $4,000 to $6,000. Within recent years salaries have advanced and in a few places reach from $8,000 to $10,000. While from the financial standpoint not much can be said for such a prospect there are many additional compensations which are worthy of consideration. Chief among these is the opportunity for constant mental growth and development, and the contact with young and inquiring minds which keeps the mind active and adaptable. Constant association with the best products of human thought, and with pleasant and congenial fellow-workers, together with opportunities for travel and study in the summer vacation constitute arguments of great weight for any one whose tastes incline to a scholastic life.

The added attraction of a career in a chair of science is that one deals with matters which are essentially of interest to our present civilization. The contributions made to human knowledge are now almost exclusively in science. Other civilizations have equalled or excelled us in many lines of endeavor, but in coming to an understanding of the real nature of ourselves and of the universe in which we live, we stand apart. An opportunity to take part in enlarging the bounds of human knowledge and in gaining control over the conditions of human existence must appeal to the imagination of any young man, who really has ambition to leave the world better than he found it. The teacher has the additional satisfaction of contributing to the forces that will continue the attack upon Nature's secrets because his students live after him.

Added to the attractiveness attaching to any scientific position the zoologist finds a compelling interest and satisfaction in studying living things and in learning from them secrets which profoundly affect his own existence. It is only necessary here to recall that Darwin, in establishing the theory of evolution, supplied a philosophy which has dominated every phase of human affairs in the last half century. Every year sees additions to our knowledge of life and its processes which make for a better and fuller human existence. The subject of zoology is so young and fertile that any capable person may hope to make a worthy contribution to it. Because of this he may well forego opportunities more attractive in a worldly way.

But should there exist a taste for scientific pursuits and a disinclination for scholastic life there are many ways in which a scientific training can be utilized outside the school room. The national government maintains extensive laboratories among which are those dealing with the applications of zoological knowledge. At present these are largely concerned with parasitological questions, but in the study of these there open up fascinating life histories of animals, and their pursuit involves travel and investigation in many lands. To one interested in fishes and their ways the Bureau of Fisheries offers many opportunities, some of which lead to ocean voyages and experiences with the mysteries of the sea.

The most extensive demand that the government makes, however, is for entomologists. Large numbers of such specialists are engaged in the study of insect life in all its aspects. A part of this work is done in the laboratories of the Department of Agriculture, but in many cases the field studies constitute a large proportion. Some of the investigations are of the most fundamental scientific value and there are projects for the exhaustive studies of life histories, such as, for instance, that of the honey bee. In this case several men give all their time to investigating, with excellent equipment, the complicated social and biological life of the hive.

As biological science grows, places are made in government departments to take advantage of the latest developments. Within recent years the subject of genetics has undergone rapid development and some of the underlying laws of heredity have become known. To extend our knowledge of these and to make them applicable to animal breeding the Department of Agriculture has established special facilities for the study of genetics and has employed men to investigate breeding problems in the most comprehensive manner. Positions thus opened are very attractive to persons desiring to follow the career of an investigator unhampered by teaching responsibilities.

The states now are also setting up laboratories which require trained zoologists. These may be in their universities and colleges or may be connected with public health departments, biological surveys, entomological commissions, or museums. Among them they offer some variety of choice but, in general, are distinguished from teaching positions by greater contact with the general public and by a larger element of administrative or regulatory work.

Similarly, large cities have established departments of public health in which there is occasional demand for zoologists, principally in entomological or parasitological studies. In some cities also there are municipal museums and zoological gardens which require zoologists trained as collectors, field naturalists and systematists in different groups. Sometimes these positions are very attractive.

Finally there are research institutions on private foundations where opportunities for zoological investigators are of the highest character. The development of these has been due largely to the failure of universities to make adequate provision for research. The rapid growth of science and the expensive equipment required for investigational work, together with the necessity of providing plenty of unhampered time for the student of new problems, has made inevitable and necessary the establishment of research institutes. Since these are well-endowed they offer attractive openings for thoroughly trained zoologists.

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GEOLOGY AS A PROFESSION

INTRODUCTION

"The geological book—the greatest historical document of the ages . . . ," these are the words of one worker after thirty active years of teaching and research. Are the attractions of geology really such that able young men of to-day may expect to be led to similar enthusiastic exclamation after their initiation into the science? To answer this question is the purpose of this paper.

RELATION TO OTHER SCIENCES

The first point which should be understood is that a liking for chemistry, physics, biology, mathematics, astronomy, or economics, excludes no one from becoming a geologist. Geology is not truly an independent science; it is a combination of other sciences directed towards a specific field of study—the earth. One of the greatest deterrents to more rapid progress in geology is the lack of broad training in other sciences; a professor of geology in a well-known university recently remarked that he would rather teach a graduate student well-grounded in other sciences and knowing little geology, than one well trained in geology and knowing little of other sciences. The fact that geology is in many ways not one of the exact sciences by no means indicates that a foundation in these is

not desirable. Many ridiculous hypotheses have been advanced in geologic theory which would never have escaped their authors' minds had some knowledge of the more exact sciences been there to hold their fancies in check. Many of the problems at present most obviously open for investigation are those on the borderland between geology, and physics or chemistry. This matter is stressed because many brilliant students are repelled from geology because of the number of questions to which "probably" or "perhaps" are the only safe answers. The converse of this is also true, that many men with a love of science have been attracted to this field for the very reason that the personal equation can enter in; and by their gifts of accurate observation, deduction and induction, such men have been able to make most important contributions.

OPPORTUNITIES IN GEOLOGY

Without attempting to make geology a sort of scientific catch-all, it is, nevertheless, evident that there is room for men of very diverse scholastic leanings. The same is true for occupational preferences; there are governmental exploring parties whose range of work extends from Alaska to Mexico; there are expeditions to distant or unexplored regions for commercial companies; there are state surveys in 41 of the 48 states; there is the teaching profession; and there is museum work. Lastly, there are opportunities in various endowed institutions, in some museums, and a few universities, for uninterrupted research. Geology not only appeals to men of diverse scientific tastes, but offers each a livelihood in the field of his choice.

POSSIBLE LINES OF INVESTIGATION

Some types of geologic investigation are described below:

First, there is investigation on the borderland between physics, chemistry, and to a certain extent astronomy, and geology. A good idea of the type of problem attacked in this field may be obtained from the list of publications of the Geophysical Laboratory of the Carnegie Institution. Here are such headings as:

Contributions to Cosmogony and the Fundamental Problems of Geology. The Tidal and Other Problems.

An Investigation into the Elastic Constants of Rocks . . .

Significance of Glass-making Processes to the Petrologist.

Methods of Petrographic Microscopic Research.

If a more detailed picture of the overlap of geology and chemistry is desired, the student need only glance through "The Data of Geochemistry," Bulletin 616, United States Geological Survey, where the almost endless inter-ramification of the two sciences is well illustrated.

Second, there is that great mass of research on the borderland between biology and geography. Types of recent topics are:

The Fossil Turtles of North America.

Iron-bearing Bacteria and their Geologic Relations.

Human Remains and Associated Fossils from the Pleistocene of Florida.

Distribution of Fossil Plants in Time and Space.

Such investigations have been carried out under the auspices of government museums, privately endowed museums, privately endowed research institutions, the United States Geological Survey, State Geological Surveys, and universities, and by teachers utilizing their spare time for independent research.

Third, there is the decided trend of many geologists toward research on the borderland between geology and economics, a useful field if competently filled. Of a recent book "Coal, Iron and War," written by a geologist, a reviewer has said that it "cuts under political and social facts" to the material influences which create them.

Fourth, there is research in commercial geology. There are two classes of commercial workers—the consulting geologist and the geologist in the employ of a single company. The first to a certain extent controls his time and has opportunity to devote considerable

energy to research. Such men have taken an active part in the development of their phase of geology and have made many valuable contributions to the subject. Those employed by a definite company have less control of their time and therefore less independence in the direction their studies take. In both cases the research is likely to contain an element of secrecy—and results of research which can not be published, no matter how good they may be, can not contribute to the advancement of the science. Recent studies show an actual decrease of published matter occurring at just about the time the call for oil geologists became pronounced. This is no indication that geologists should not go into professional geologic work, but it does point out that if a man feels he would enjoy the publication of the results of his research, there are far better openings than commercial work in his particular case.

There seems to be no need of discussing the various fields of what is more commonly considered geology. The sources of support are the same as above and the opportunities for subjects of study as endless as the topics of the text-books. Stratigraphy, physiography, economic geology, dynamical, and historical geology, with their accompanying theoretical aspects, all offer their attractions according to the taste of the investigator.

COMPENSATION

Compensation is unquestionably of two sorts—material and mental. In material compensation, there can be no doubt that the practising geologist leads. He also has the satisfaction that comes from active participation in the development and winning of material wealth. There is, however, a field of research where the results are not utilitarian and are of no apparent practical value. Here the financial reward is less, but there comes instead what to many men is the greatest joy of life—the personal discovery of new facts and the increase of human knowledge. A geologist said recently "I am doing just what I would do if I had a million dollars." The true research spirit has in it also an underlying motive of service to humanity. The reading of biography or personal observation will surely verify this statement.

> Great advances of the future are not dependent upon having every man do everything as an expert, but they will rest upon a wide appreciation of the importance of constructive thought, of organized knowledge, and of the continuous advance of knowledge.[1]

If a man's inclination is to add to this "continuous advance of knowledge" by personal effort, he may be sure that he will eventually feel well paid.

GEOLOGY AS A PROFESSION[2]

Why enter geology as a profession? The reasons are most diverse and will make varying appeals according to the likes and dislikes of the individual. No claim is made that the facts advanced are all peculiar to geology, but the combination of advantages is certainly hard to match elsewhere.

For the sake of clarity these reasons will be discussed under numerical headings.

1. *The science is young.* Any man of good ability may hope to make worth while contributions to it. The joy of discovery, already alluded to, is open to all.

2. *The range of possible employment is large.* The three most open to the beginner are teaching, work under government or state bureaus, and commercial employment. If one type of work proves distasteful, there are opportunities to utilize the same training in a different occupation. This fact has been amplified on a preceding page.

3. *The investigator may feel that his work has an intimate relation with the winning and best utilization of the raw materials which contribute to national and world prosperity.* This is often true even if his tastes lead him in fields which seem to have no relation to the practical needs of man. Berry,

[1] Address by J. C. Merriam. See SCIENCE for November 19, 1920.

[2] The writer wishes to acknowledge indebtedness to a splendid paper by R. D. Salisbury, in SCIENCE, April 5, 1918, for much that is good in the following discussion.

in reviewing a recent work on foraminifera, has pointed out that these microscopic animals "have lately been shown to be of profound significance in the location of oil sands . . . in the Texas oil fields."

4. *The geologist has the pleasure of realizing close bonds with many kinds of people and many fields of human interest.* The successful operation of the federal leasing law depends on the work which many young geologists have been doing in the different sections of the country in past summers. In the settlement of post-war problems in economics, the word of the geologist (and geographer) carried much weight. In matters of conservation and the establishment of national parks he holds an honorable place. And his influence on religious thought has been and still is great.

Geology means contact with people. The geologist in his field work often meets woodsmen, Indians, cowboys, pioneer agriculturalists, prospectors and miners; in consulting work, he deals with "big business"; in classroom or office, with highly trained university men; often his lot is cast with all three types many times in the course of a year. He must develop tact, an understanding and appreciation of people of various kinds, and an ability to adapt himself to varying conditions of life. Incidently, he will probably keep alive the "milk of human kindness." Geology may not be a humanistic subject, but it is a thoroughly human subject.

5. *The character of the science is such as to develop the quality of good judgment.* Geology being young and many theories still debatable, the first duty of the geologist is to consider the evidence and accept those theories according best with the known facts. Due, perhaps, to this and the preceding fact, many geologists have filled positions as college presidents, executive officers, and public servants with exceptional tact, skill, and integrity.

6. *The geologist derives great reward from his intimate understanding of nature.* No journey is so long, no desert so drear, no mountain so forbidding, no streamlet so small, no life so insignificant, that it does not bring with it some intimate revelation and fellowship. As is often said of religion, this is something which needs to be experienced to be understood. It is a wonderful possession to have and a wonderful gift to impart to others as teacher and as investigator. The geologist may not express his thoughts in a "Psalm of Life" as did Longfellow after viewing a fossil foot-print, but his inspiration may be even greater from his fuller understanding of its meaning.

7. *Geology is an invigorator—physically.* The researches of the active geologist will take him into the open, far away from the contaminated air of city and laboratory, for several weeks or months, each year. Few other learned professions can offer this inducement to their votaries. The geologist must love the out-of-doors and from this love he will draw physical fitness. Geology is pre-eminently a profession for the red-blooded, athletic type of man.

8. *Geology is an invigorator—morally and spiritually.* Consider the title of papers by some of the present-day leaders—J. M. Clarke, "The philosophy of geology and the order of the state"; T. C. Chamberlin, "A geologic forecast of the future opportunities of our race"; G. O. Smith, "Geology and the public service"; read the concluding paragraphs of text-books on geology; consider the closing words of a recent address before an important gathering of geologists—

> The student of earth sciences was once a contributor to the wider philosophy of nature. It may be his duty now to make sure, not only that his influence is felt in advancement of material welfare, but that he serve also to point out the lesson of the foundations of the earth, and to show that strength may still come from the hills.

In conclusion, for one who has scientific leanings, who cares for investigation, and who has ability, geology offers health, an optimistic outlook on life, human intercourse, abundant opportunity for research, and withal, a livelihood.

H. P. Little

National Research Council

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

REPORT OF THE AUTUMN MEETING OF THE EXECUTIVE COMMITTEE OF THE COUNCIL

THE meeting was called to order in the office of *The Science Press*, in the Grand Central Terminal Building, New York City, at 3 o'clock, November 20, 1921, Chairman Flexner presiding. The following members were present: Cattell, Fairchild, Flexner, Howard, Humphreys, Livingston, MacDougal, Moore, Osborn, Ward. Excepting A. A. Noyes, the entire committee was present.

1. The minutes of the last meeting (April 24, 1921) were approved as mailed to all members of the committee.

2. The permanent secretary's report was considered in some detail and was accepted and ordered filed. A résumé follows:

The Summarized Proceedings was published October 10. The membership list was closed June 15, so that the published list is corrected only to that date. 2,300 copies were printed at a cost of $5,378.58. The preparation of the manuscript cost $1,313.73 as extra clerical expenses. Adding this amount to the cost of publication gives $6,692.31. This total cost of the book is partially offset by sales of 1,796 copies amounting to $2,183.00. The book thus cost the Association $4,509.31 net, chargeable against the seven years, 1915 to 1921. 130 copies were given away, of which 74 went to general officers, section secretaries, and secretaries of affiliated societies, for their official use. Of the remaining 56 free copies, 53 were complimentary to institutions and libraries outside of the United States, and 3 copies were sent out on account of exchanges.

Three Booklets were printed and circulated since the last meeting of the executive committee. By means of one of these the *resolutions* recently adopted by the Association were placed in the hands of all members. About 12,500 copies of that booklet were sent out. *A booklet of general information* was used in the circularization for new members (about 25,000 have been sent out), and another *booklet announcing the Toronto meeting* was sent to all members with the bills of October 1.

New members of the affiliated societies and all members of the newly affiliated societies (The American Mathematical Society, The Mathematical Association of America, The American Geographical Society, The American Society for Testing Materials, The American Society of Agronomy, The Society of Sigma Xi, and the Gamma Alpha Graduate Scientific Fraternity) were invited to join the Association without entrance fee, as far as the necessary lists could be procured. About 20,000 such invitations have been sent out and about 10,000 more will go out when the lists arrive from the society secretaries. 4,300 names for circularization were obtained from the new volume of "American Men of Science." (To Nov. 20, this circularization—of about 24,300 names—has secured 557 new members.) A tabulated membership report will be published later.

3. The general secretary's verbal report was accepted. He reported correspondence with the Utah Academy of Science. This Academy has altered its movement for separation from the Pacific Division. He had been in consultation with officers of sections, and it was believed that stronger council sessions would result at future meetings. He reported that arrangements were being made by which various different interests have been centered in the program of Section C for the Toronto meeting.

A recess, from 6:30 to 8:00, was taken for dinner, after which the committee convened again.

4. Mr. J. B. Tyrrell was elected chairman of Section M and vice-president for that section.

5. Mr. L. W. Wallace was elected secretary of Section M.

5a. Dr. A. B. Macallum, professor of biological chemistry at McGill University, was elected a vice-president, and chairman of Section N.

6. Fifty-six fellows were elected, distributed among the sections as follows:

A	B	C	D	E	F	G	M	O	Q
6	3	3	1	4	19	3	2	14	1

7. The American Society of Mammalogists was constituted an affiliated society.

8. It was voted that the American Ceramic Society be invited to become associated and to become affiliated if the number of A. A. A. S. members in the society should prove to warrant affiliation.

9. The Phi Delta Kappa Fraternity was invited to become an associated society.

10. The Canadian Society of Technical Agriculturists was invited to become an associated society.

11. The petition of 32 members resident in State College, Pa., dated November 1, was granted, thus constituting a local branch in that place, to be known as the State College (Pa.) Branch of the A. A. A. S. The branch is to receive 50 cents for each payment of annual dues made to the A. A. A. S. by its members.

12. It was voted that the committee regards it as

desirable that the next volume of Summarized Proceedings be published in fall of 1925, to include the proceedings of the 1924 (Washington) meeting.

13. It was voted that the executive committee recommend to the Council that the 1925 meeting (for the year 1925–6) be held at Kansas City, Mo.

14. The general secretary was instructed to communicate with the Pacific Division and to say that if the Pacific Executive Committee arranged its summer meeting for 1922 in Salt Lake City, the executive committee would consider the matter of arranging a meeting of the whole Association for that time and place.

15. The permanent secretary was instructed to invite all past presidents to be present at the Toronto meeting, especially to attend the sessions of the council at Toronto and to take part in the council's deliberations.

16. The general secretary was asked to invite one or more Russian scientists to attend the Toronto meeting.

The meeting adjourned at 10 o'clock, to meet in Toronto, at 10 A.M. on Tuesday, December 27.

Burton E. Livingston,
Permanent Secretary

EDUCATIONAL EVENTS

AN AMERICAN BAMBOO GROVE OPEN TO INVESTIGATORS

Research men connected with the state and other institutions are invited to visit the bamboo grove at Savannah on the Ogeechee Road. This grove covers an acre of ground, and the culms rise fifty-five feet into the air, producing a dense forestlike effect with their smooth dark green culms three and four inches in diameter. It is the largest grove of the Madane bamboo (*Phyllostachys bambusoides*) east of the Mississippi and comparable in beauty to groves of similar size in Japan. Any botanist who has never seen a bamboo grove has waiting for him a thrilling experience, for the sight of a giant grass over fifty feet tall changes one's ideas of grasses just as the sight of a victoria regia changes one's ideas of water lilies or the discovery of the pterodactyl changed our ideas of lizards and birds. A simple laboratory, which is being equipped with limited living accommodations, stands in the center of the grove, and its facilities are at the disposal of the research workers of the Department of Agriculture and other institutions upon application to this office.

While the grove is wonderfully interesting at any time, it is peculiarly fascinating about the middle of April when the new shoots four inches in diameter are coming through the ground and shooting skyward at a great rate.

Botanists to or from Florida should by all means stop and see this grove. It lies twelve miles from Savannah on a new concrete highway, the Ogeechee Road. Long distance telephone central will connect anyone with the "Government Bamboo Grove," and they can talk with Mr. Rankin, the superintendent.

David Fairchild

Office of Foreign Seed and Plant Introduction,
Bureau of Plant Industry

FLIGHTS OF HOUSE FLIES

That the house fly not uncommonly makes a journey of five to six miles in the space of twenty-four hours is shown by experiments conducted by the Bureau of Entomology, United States Department of Agriculture. The ease with which flies travel many miles shows the importance of general sanitary measures to destroy breeding places. Fly flight tests were conducted in northern Texas, where approximately 234,000 flies of many different species were trapped, then dusted with finely powdered red chalk, and liberated. Fly traps baited with food highly relished by the flies were placed at measured intervals in all directions from the points of release. By means of these secondary traps, it was possible to determine the direction and flight of different species of flies. The tests showed that the flies, after regaining their freedom, would travel distances up to 1,000 feet in a few minutes. The screw-worm fly evidenced its power to cover a half mile in three hours, while the black blowfly traveled anywhere from half a mile to eleven miles during the first two days' release. The house fly covered over six miles in less than twenty-four hours. Observations at the Rebecca Light Shoal off

the coast of Florida seemed to show that flies come down the wind from Cuba (ninety miles distant), and at times from the Marquesas Keys (twenty-four miles distant), and even from Key West, Fla., forty-six miles away. The maximum distance traveled by the house fly in these experiments was 13.14 miles. The tests proved that the injurious forms of fly life were not distributed on any large scale by artificial means, but rather that many of the far-flying species showed marked migratory habits.

IMPACT ON BRIDGES

A new instrument devised by the Bureau of Public Roads of the United States Department of Agriculture measures with scientific precision the effect of every shock and blow delivered by moving vehicles in crossing a bridge. Attached to any part of the bridge structure, this instrument makes a photographic record of the effect of the moving load. The amount of stretching or shortening of the part as a result of the shocks is represented by a fine black line on the photograph. No blow or shock can be delivered so quickly that the instrument will not record its effect. It has never before been possible to measure the effect of such blows. Engineers have long been able to calculate the effect of standing loads very exactly; but because of their inability to measure the effect of quickly delivered blows or impacts, they have never been able to proportion the various parts of a bridge with absolute assurance. It has been necessary to make a liberal allowance for this unknown quantity. In some cases the allowance has not been sufficient and the bridges have collapsed under moving loads. Many bridges still in service are probably too weak to withstand safely the sharp blows of swiftly moving vehicles, though they will safely carry the same vehicles at rest or moving at a slow speed. The familiar warning posted at the portals of a bridge: "Speed limit on this bridge 8 miles per hour," means that the design of the bridge to which it is attached is not strong enough to allow for impact. In the light of the recent experiments with motor trucks in which it was shown that a swiftly moving motor truck may strike a blow equivalent to seven times its actual weight, it is rather surprising, the department road experts say, that failures have been so few. It is believed this new measuring instrument will soon do away with uncertainty. The knowledge gained by its use will enable the engineer to design bridges which are sure to hold up under fast-moving vehicles, and to build such bridges without undue waste of material and money.

THE TORONTO MEETING

The section of medical sciences of the American Association has arranged the following program:

Vice-presidential Address: "The past and the future of the medical sciences in the United States": Professor Joseph Erlanger, professor of physiology, Washington University.

"Hereditary factors in development": Dr. Charles B. Davenport, director of the Laboratories for Experimental Evolution of the Carnegie Institution.

"The metabolism of children in health and disease": Professor Harold Bailey, Cornell Medical School, N. Y.

"Newer aspects in dietetics of children": Dr. Alfred Hess, College of Physicians and Surgeons, New York.

"Movie exhibition of tonsil-adenoid clinics in operation": Dr. George W. Goler, health officer, Rochester, N. Y.

"The mental hygiene of children": Dr. C. M. Hincks, associate medical director, Canadian National Committee for Municipal Hygiene, Toronto, Canada.

Professor E. S. Moere, secretary of the section of geology and geography, writes:

The section has prepared a very interesting program for the Toronto meeting and the officers of the section will be glad to hear at once from any of the members who wish to contribute. While the meetings of the other societies affiliated with the association are drawing many of the geologists and mineralogists from this side of the international boundary to Amherst, quite a number are going to take part in the Toronto meeting and the Canadian geologists are most heartily cooperating in preparation for the meeting. Many of the geologists of the Canadian Geological Survey and

of the Canadian universities have prepared papers and some of them dealing with new geological fields will be of special interest. Dr. Eliot Blackwelder, at present at Harvard University, will deliver his address as retiring vice-president of this section on "The trend of earth history." It is intended that the geological and engineering sections will combine for a banquet.

The second meeting of geneticists interested in agriculture will be held at Toronto, on Tuesday, Dec. 27.

The program will take up "The genetics curriculum in the college of agriculture." Discussion of various phases of the subject will be opened as follows: (1) The elementary course in genetics. Prof. C. B. Hutchinson, Cornell University. (2) Advanced courses in genetics. Prof. J. A. Detlefsen, University of Illinois. (3) Laboratory courses in genetics. Prof. A. C. Fraser, Cornell University. (4) Genetics preparation for research in other fields. Dr. E. D. Ball, U. S. Department of Agriculture. Invitation to attend and to participate in the discussions is extended to all who may be interested, whether or not they are connected with agricultural institutions, since the topic really comprehends the general subject of genetics teaching. It is hoped to have a good attendance of those concerned with the teaching of applied courses in plant and animal breeding.

SCIENTIFIC NOTES AND NEWS

Henry Turner Eddy, professor emeritus of mathematics and mechanics in the University of Minnesota and dean emeritus of the graduate school, died on December 18 at the age of seventy-seven years.

Dr. Ernest Fox Nichols, who recently resigned the presidency of the Massachusetts Institute of Technology, is to return to Cleveland to resume the directorship of pure science in the Nela Research Laboratory, maintained by the National Lamp Works of the General Electric Company.

Stevens Institute of Technology held a fiftieth anniversary banquet at the Hotel Astor, New York City, on December 15. A silver loving cup was presented to Professor Charles Kroeh, secretary of the faculty, who has been professor of modern languages at Stevens ever since it was founded. The speakers were Dr. Alexander Humphreys, president, Dr. John H. Finley and Mr. Job E. Hedges.

The Howard N. Potts gold medal and diploma of the Franklin Institute have been conferred upon Alfred Q. Tate for inventions which have created the new art of electrolytic waterproofing of textile fabrics.

Philip L. Gile, formerly connected with the American Agricultural Chemical Company and for eleven years previously chemist of the Porto Rico Agricultural Experiment Station, has been placed in charge of the division of soil chemical investigations of the Bureau of Soils, U. S. Department of Agriculture.

Ralph Stone, member of the staff of the United States Geological Survey, has left the federal service to become assistant state geologist of Pennsylvania.

Mr. James E. Ives has resigned as research associate and lecturer in physics at Clark University to become physicist in the office of industrial hygiene and sanitation of the Public Health Service in Washington.

Dr. C. G. Abbot of the Astrophysical Observatory is at present in Antofagasta, Chile, at the solar radiation station on Mt. Montezuma. He expects to return in January.

C. H. Birdseye, chief geographer for the U. S. Geological Survey, left Washington on November 30, to inspect the map-making activities of the Survey in the West and in Hawaii.

J. W. Gilmore, professor of agronomy, College of Agriculture of the University of California, has returned from the University of Chile, Santiago, Chile. Professor Gilmore has been exchange professor with this university for the past six months. While in Chile he was in consultation with the Chilean authorities with a view toward improving the agriculture of the western coast of South America.

DR. MORTEN P. PORSILD, director of the Danish Arctic Station, Disko, Greenland, is at present in Copenhagen, Denmark, where he is making plans for a visit to England and America. In December and January he will lecture at the University of Cambridge, England, on botanical and ethnological subjects. He expects to reach the United States about the middle of February and may lecture at scientific centers.

DR. CLEMENT PIRQUET, Dr. Charles Wardell Stiles and Dr. Alfred F. Hess, have been appointed to give this year the Cutter Lectures on Preventive Medicine under the auspices of the Harvard Medical School. Dr. Pirquet is professor of pediatrics at the University of Vienna and is best known for his work on behalf of the under-nourished children of Austria since the war. Dr. Stiles is assistant surgeon general of the U. S. Public Health Service and consulting zoologist of the Bureau of Animal Industry in the Federal Department of Agriculture; Dr. Hess is a New York pediatrist.

DR. E. M. EAST, of the Bussey Institution of Harvard University, gave a series of lectures at Cornell University, December 8–10, 1921, as follows: "Problems of population in relation to agriculture," to the Society of Sigma Xi; "Inbreeding as a tool in plant improvement," to the staff and students of the College of Agriculture, and "The problem of self-sterility in plants," to the seminary of the department of plant breeding.

HENRIETTA SWAN JEWETT, of the Harvard College Observatory, died on December 19. Since 1902 she had been engaged in the study of the photographic brightness of the stars and the distribution and periods of variable stars.

THE Elizabeth Thompson Science Fund has been serviceable for many years in giving aid, by small grants, to research which otherwise might not be readily undertaken. The grants are made only for scientific investigations and must be applied to actual expenses of the research, *i.e.*, they are not made to support an investigator or to meet the ordinary expenses of publication. The trustees give preference to researches involving international cooperation. The grants are not made for researches of narrow or merely local interest, nor are they available for equipment of private laboratories or for purchase of apparatus ordinarily to be found in scientific institutions. Applications for grants from this fund should be made before January 15, 1922, to Professor W. B. Cannon, secretary of the trustees of the fund, Harvard Medical School, Boston, Mass.

THE Fifth National Medical Congress of Cuba, which takes place every five years, will be held from December 11 to 17, under the presidency of Professor J. A. Presno, founder and director of the *Revista de Medicina y Cirurgia* of Havana.

ADOLPH LEWISOHN has given $150,000 for the pathological laboratory of Mount Sinai Hospital, New York City. The gift is in addition to others to the hospital and laboratory made by Mr. Lewisohn, including a similar amount for the laboratory.

THE Committee of the Universities' Library for Central Europe, formed in England to renew the stocks of books and scientific and learned periodicals in the universities of Central Europe, has recently issued its report for its first year of working, ending March 31, 1921. It has sent consignments of literature to Austria, Czecho-Slovakia, Esthonia, Germany, Hungary and Poland. Donations of money and English books published since 1914 are still urgently needed, and may be sent to the honorary secretary, Mr. B. M. Headicar, London School of Economics, Clare Market, W. C. 2.

THE Sarah Berliner Fellowship for research in physics, chemistry or biology is now of the value of from one thousand to twelve hundred dollars. In view of the fact that some of the holders of this fellowship have given important courses of lectures at Cornell, the Johns Hopkins, Yale and other universities, the committee in charge of the fund has decided to give explicit recognition to this aspect of the fellowship. Hereafter, therefore, preference will be given those candidates who can carry on research and at

the same time have the privilege of giving one or more courses of lectures at some university or institution of learning.

UNIVERSITY AND EDUCATIONAL NEWS

President Angell has announced that Mrs. Stephen V. Harkness of New York is the hitherto unnamed friend of the University whose conditional gift of $3,000,000 was made public by President Hadley at the Commencement alumni dinner in 1920. Mrs. Harkness's gift of $3,000,000 was made conditional upon the securing of an additional $2,000,000 from alumni and other friends which was pledged on October first, 1921. In her original letter of gift, dated April 5, 1920, Mrs. Harkness stated: "I am informed that Yale University has recently increased the salaries of the members of its several faculties. . . . This action seems to me to be in accord with the general feeling of its alumni and friends, that those who are devoting their lives, with little or no opportunity for large pecuniary rewards, to the teaching of young men and women and the moulding of their characters and opinions, should receive so far as possible a compensation sufficient always to attract persons of ability and standing."

Earl B. Young has been elected professor of geology at the Montana School of Mines, Butte, Mont.

DISCUSSION AND CORRESPONDENCE

THE NATIONAL ACADEMY OF SCIENCES AND THE METRIC SYSTEM

To the Editor of Science: The National Academy of Sciences at its meeting in Chicago in November, on request, considered the bill introduced in the Senate by Senator E. F. Ladd, which reads as follows:

67th Congress,
1st Session

S. 2267

IN THE SENATE OF THE UNITED STATES
July 18, 1921

Mr. Ladd introduced the following bill; which was read twice and referred to the Committee on Manufacturers.

A BILL

To fix the metric system of weights and measures as the single standard of weights and measures for certain uses

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and after ten years from the date of passage and approval of this Act the weights and measures of the meter-liter-gram or metric system shall be the single standard of weights and measures in the United States of America for the uses set out herein.

Sec. 2. That the national prototypes of the fundamental standards of the metric system shall be the copies of the standards known as meter numbered twenty-seven and kilogram numbered twenty, allotted to the United States by the General Conference of Weights and Measures held at Paris in 1889. These are now deposited in the vault of the Bureau of Standards of the Department of Commerce and those which are now used and employed in deriving the values of all weights and measures used in the United States. These national representations are hereby adopted as the primary standards of weights and measures for the United States of America, and from these all other weights and measures shall be derived and ascertained.

Sec. 3. That from and after ten years from the date of passage and approval of this Act no person shall do or offer or attempt to do any of the following acts, by weights or measures, in or according to any other system than the metric system of weights and measures, namely:

(1) Sell any goods, wares, or merchandise except for export, as provided in section 8;

(2) Charge or collect for the carriage or transportation of any goods, wares, or merchandise.

Sec. 4. That from and after ten years from the date of passage of this Act no person shall use or attempt to use in any of the transactions detailed in section 3 any weight or measure or weighing or measuring device designed, constructed, marked, or graduated in any other system than the metric system of weights and measures.

Sec. 5. That not later than ten years from the date of passage and approval of this Act all postage, excises, duties, and customs charged or collected by weights or measures by the Government of the United States, shall be charged or collected

in or according to the metric system of weights and measures.

Sec. 6. That rules and regulations for the enforcement of this Act not inconsistent with the provisions hereof shall be made and promulgated by the Secretary of Commerce. The Secretary of Commerce shall also take such steps as he may deem expedient for giving publicity to the dates of transition specified herein and for facilitating the transition to the meter-liter-gram or metric system.

Sec. 7. That all Acts or parts of Acts inconsistent herewith are hereby repealed but only in so far as they are inconsistent herewith; otherwise they shall remain and continue in full force and effect. Whenever in any Act, or rules and regulations, or tariff or schedule made, ratified, approved, or revised by the Government of the United States of America weights or measures of the system now in customary use are employed or referred to, and to comply with the provisions of this Act weights and measures of the metric system should be employed, then such references in such Act, rules and regulations, tariff, or schedule shall be understood and construed as references to equivalent weights or measures of the metric system ascertained in accordance with the required degree of accuracy.

Sec. 8. That nothing in this Act shall be understood or construed as applying to—

(1) Any contract made before the date at which the provisions of this Act take effect;

(2) The construction or use in the arts, manufacture, or industry of any specification or drawing, tool, machine, or other appliance or implement designed, constructed, or graduated in any desired system;

(3) Goods, wares, or merchandise intended for sale in any foreign country, but if such goods, wares, or merchandise are eventually sold for domestic use or consumption then this clause shall not exempt them from the application of any of the provisions of this Act.

Sec. 9. That nothing herein shall be understood or construed as prohibiting the enactment or enforcement of weights and measures laws or ordinances by the various States or cities, and the various States or cities shall have the same powers as though this Act were not in force and effect: *Provided, however,* That no standard weights or measures shall be established for the uses set out herein which conflict in any way with the standards established herein, and such standards which may already have been established shall be null and void for the uses set out herein.

Sec. 10. That the word "person" as used in this Act shall be construed to import both the plural and singular, as the case demands, and shall include corporations, companies, societies, and associations. When construing and enforcing the provisions of this Act, the act, omission, or failure of any officer, agent, or other person acting for or employed by any corporation, company, society, or association, within the scope of his employment or office, shall in every case be also deemed to the act, omission, or failure of such corporation, company, society, or association as well as that of the person.

After discussion, the bill was referred to the Committee on Weights, Measures, and Coinage of the Academy for report, with power to act through the President of the Academy. Upon receipt of the report from the Chairman of that Committee, Dr. Thomas C. Mendenhall, the following communication was sent to Senator Ladd:

December 1, 1921

My dear Senator Ladd: Referring again to my recent communications regarding bill S2267 to fix the Metric System of Weights and Measures as the single standard for certain uses, I have received a report from the Committee on Weights, Measures, and Coinage, which was authorized to act for the National Academy of Sciences, approving bill S2267 with the following statement:

"Any measure that might now be passed is tolerably certain to need modification and amendment before the end of the probationary period."

Very truly yours,

(Signed) CHARLES D. WALCOTT,
President

As Senator Ladd has requested that publicity be given to this action of the Academy, I am sending you this statement for inclusion in SCIENCE.

CHARLES D. WALCOTT,
President

STAINS FOR THE MYCELIUM OF MOLDS AND OTHER FUNGI

TO THE EDITOR OF SCIENCE: Microscopic examinations to determine the extent to which the mycelium of various fungi has penetrated infected specimens of wood consume an unduly large amount of time. Methods using organic substances, dyes and stains, to obtain a differ-

ential coloring that will make mycelium stand out in contast to the tissue of the host have been described.[1]

The writers, in an attempt to obtain a stain which would reduce the time required for the examinations of a set of woods infected with molds by producing satisfactory differentiation both for visual examination and for photomicrography, have worked out the following method. The results, although the work is only in the preliminary stage, are so promising that they are given here in order that others may avail themselves of the method if they desire to do so.

Since there is a difference in chemical composition between wood substance and chitin or "fungous cellulose," the assumption was made that the fungous mycelium might possess characteristic mildly oxidizing or reducing properties. Then a solution of silver nitrate in distilled water was applied to thin sections of the infected wood. These were allowed to stand for periods of various lengths, overnight staining giving a very satisfactory result. The sections were then examined directly or dehydrated with alcohol, cleared with xylol, and mounted in Canada balsam. Drying the balsam mounts under weights in an oven over night appeared, if anything, to improve the stain secured.

Both conifers and hardwoods were treated in this way. The mycelium of several molds and of two wood-destroying fungi has thus far been stained. In all cases the mycelium was differentiated by its blackish brown, purplish brown, or orange color. The wood tissue presented, if stained, a lighter shade of yellowish brown against which the mycelium was readily visible, often under relatively low magnifications.

Silver nitrate solution also gave interesting staining of the wood structures and cell contents which will be discussed at some future time.

Gold chloride solution, and the "Berlin Blue" stain, the latter as described by Dr. Sophia Eckerson in her course in microchemistry,[2] were also used with some success for the same purposes as the silver nitrate.

M. E. Diemer,
Chemist,
Eloise Gerry,
Microscopist
Forest Products Laboratory,
U. S. Department of Agriculture,
Madison, Wisconsin

[1] Sinnott, E. W. and I. W. Bailey, *Phytopath.*, 4: 403, 1914. Vaughan, R. E., *Ann. Mo. Bot. Gard.*, 5: 241, 1914 and others.

[2] Text-book now in preparation.

SHARKS AT SAN DIEGO

To the Editor of Science: It has occurred to the writer that a very brief statement of some experiences in collecting shark material at San Diego, Cal., in 1920–21 might be of value to persons interested in research problems in elasmobranch morphology and embryology. Owing to the fact that the reduction plants in San Diego paid in 1920–21 a price for sharks high enough to make it worth while for the fishermen to bring in all such material caught incidentally, and since nearly all such material was brought to the fishmarket pier, at the latter place it was possible in a very short time to collect a considerable range of species. The writer obtained twenty-six species of elasmobranchs at San Diego, and the embryos of fourteen of them. No other place along the Pacific coast, or probably on any other coast, offers such a wealth of material and such easy access to it. It was not uncommon to see fifteen species of elasmobranchs at one time on the pier at San Diego.

H. W. Norris
Grinnell College

MUNICIPAL OBSERVATORIES

To the Editor of Science: In Science for August 5, the Municipal Observatory at Des Moines is "said to be the only municipal observatory in the world." The Cincinnati Observatory was incorporated in 1842, its corner stone being laid in 1843 by John Quincy Adams. Here Cleveland Abbe (director '68–'73) first issued daily weather reports and laid the foundation of the U. S. Weather Bureau. In 1872, the property was transferred to the University of Cincinnati (municipal) on condition that the city sup-

port the observatory, which has since been done. The observatory now receives by law the income of a tax levy of one twentieth of a mill.

NEVIN M. FENNEMAN

UNIVERSITY OF CINCINNATI,
December 2, 1921

SCIENTIFIC BOOKS

THE ORDER OF NATURE

The Principles of Natural Knowledge, by A. N. Whitehead, Cambridge University Press, 1919.

L'Unité de la Science, by Leclerc du Sablon. Félix Alcan, Paris, 1919.

The Order of Nature, by Lawrence J. Henderson. Harvard University Press, 1917.

The System of Animate Nature, by J. A. Thomson. Two volumes. Williams and Norgate, London, 1920.

In the first dialogue between Hylas and Philonous Berkeley has the latter to say: "I am not for imposing any sense on your words: you are at liberty to explain them as you please. Only, I beseech you, make me understand something by them." The author of "The Principles of Natural Knowledge" has obviously had before him not only this demand, which he sets forth by giving the foregoing quotation on his title-page, but also the further one that every intelligent reader shall understand the same things by his words. Neither of these ideals is easily realized in philosophical writings; and this is most emphatically true of those which are addressed to readers not interested in the technical aspects of philosophy. Why does this difficulty exist? "We have to remember that while nature is complex with timeless subtlety, human thought issues from the simple-mindedness of beings whose active life is less than half a century."

The author seeks to realize clarity by the so-called "method of logical atomism" which "has gradually crept into philosophy through the critical scrutiny of mathematics" and in his discussion to substitute "piecemeal, detailed and verifiable results for large untested generalities recommended only by a certain appeal to the imagination," to use Bertrand Russell's characterization of the philosophy of logical atomism. Whitehead analyzes thought into elements which the unsophisticated mind could never recognize as parts of its original thought content; and sometimes even for the expert, one must believe, there is real difficulty in putting together the parts so as to recover the whole. But the reader is not in doubt as to what the author says or what he means. Whitehead says:

"The fundamental assumption to be elaborated in the course of this enquiry, is that the ultimate facts of nature, in terms of which all physical and biological explanation must be expressed, are events connected by their spatio-temporal relations, and that these relations are in the main reducible to the property of events that they contain (or extend over) other events which are parts of them." Time is not a succession of instants. but a complex of interlocking events, each helping to tie the others to the past and the future. "The conception of the instant of time as an ultimate entity is the source of all our difficulties of explanation. . . . Our perception of time is as a duration."

The work as a whole contains a somewhat technical and rather disjointed analysis of four matters, namely: the traditions of science; the data of science; the method of extensive abstraction; the theory of objects. The book will have its greatest appeal to the reader of considerable mathematical maturity, even though it does not at all depend on mathematical detail; for the point of view is evidently taken in the light of the recent philosophy of mathematics.

In "L'Unité de la Science" by M. Leclerc du Sablon we have an equal clarity, but it differs from that of Whitehead's work in being strongly marked by French characteristics.

In his preface Whitehead says: "In matters philosophic the obligations of an author to others usually arise from schools of debate rather than from schools of agreement. Also such schools are the more important in pro-

portion as assertion and retort do not have to wait for the infrequent opportunities of formal publication, hampered by the formidable permanence of the printed word. At the present moment England is fortunate in this respect. London, Oxford and Cambridge are within easy reach of each other, and provide a common school of debate which rivals schools of the ancient and medieval worlds." The authors of the first and last books under review have evidently profited much by such frequent interchange of opinion and this matching of judgment to opposed judgment. Doubtless some parts of the other two books would have been modified if their authors had more freely discussed certain controversial points with persons of a different opinion. This applies particularly to the philosophic aspects of the books, but does not affect their more positive contributions.

The philosophical part of "L'Unité de la Science" is not strong. It is sometimes naïve. In particular, the psychological theory underlying the first chapter is far from being satisfactory. But numerous scientific theories and experiments are analyzed in a way to be profitable. For M. Leclerc du Sablon unity of science is a unity of method. The scientific method, par excellence, is the experimental method. Working himself in the field of biology, where deduction is less frequently used than in several other disciplines, he has failed to grasp its whole importance. The experimental character of science is emphasized to the detriment of its rational character. The author insists (wrongly we think) that all reasoning, even that of induction, can be reduced to the form of syllogism. A first demand for science is its objectivity. The principle of causality (both direct and inverse) lies at the root of all science. Phenomena are irreversible. Beginning with arithmetic and geometry, the author analyzes, from the point of view of unity, each of the several fundamental sciences of nature. He devotes one chapter to the moral sciences. He sums up his principal findings in a useful conclusion of ten pages. The book is interesting and valuable; but it does not reach the height of being an inspiring contribution to the philosophy of science.

The purpose of Henderson's "Order of Nature" is more restricted. This essay professes to demonstrate the "existence of a new order among the properties of matter" and to "examine the teleological character of this order." Modern science is said to have failed to make a systematic study of adaptability, which (it is maintained) is at bottom "a physical and chemical problem uncomplicated by the riddle of life," even though it is true that "the organism and the environment each fits and is fitted by the other." The author asks, "What are the physical and chemical origins of diversity among inorganic and organic things, and how shall the adaptability of matter and energy be described?" To this question he reaches an answer with such remarkable ease as almost to cast doubt upon its validity; nevertheless it must be admitted that he has marshaled much evidence for his conclusion.

"What is known with certainty about the history of the earth enables us to see that a few elements, and especially the four organic ones, are the chief factors. Among these nitrogen plays a somewhat subordinate rôle, especially in the mineral kingdom, while hydrogen, carbon, and oxygen, notably as constituents of water and carbon dioxide, are almost everywhere of equal importance." After discussing rather fully the characteristics of the latter three elements the author says, "We are therefore led to the hypothesis that the properties of the three elements are somehow a preparation for the evolutionary process. In truth this is the only explanation of the connection which is at present imaginable. . . . The connection between the properties of the three elements and the evolutionary process is teleological and nonmechanical."

Each of the four authors under review is evidently convinced of the truth of what one of them (Henderson) states explicitly, namely, that "men of science can no longer

shirk the responsibility of philosophical thought." The philosophy of these four, with the possible exception of Whitehead, is general and non-technical in character and is addressed primarily to those who have a trend in the direction of science. For the "general reader" the investigation of Whitehead is rather too technical and special; the work of Leclerc du Sablon is elementary and somewhat rarefied, being dispersed over too wide a range of subjects to help much in forming a scientific philosophy to live by; the work of Henderson is moved by a too narrow view, and he exhibits what Thomson in another connection speaks of as the false simplicity of materialism; but in "The System of Animate Nature" we have a magnificent contribution to the foundations of a philosophy of biology of such sort as to find a secure place in the lives of people of intelligence whether devoted to scientific pursuits or following other interests.

At the front of the two volumes of his Gifford lectures on "The System of Animate Nature" Thomson sets the following classic quotation from Francis Bacon: "This I dare affirm in knowledge of Nature, that a little natural philosophy, and the first entrance into it, doth dispose the opinion to atheism, but on the other side, much natural philosophy and wading deep into it, will bring about men's minds to religion." Thomson insists that "the scientific picture has satisfied very few thinkers of distinction, the chief reason being that the contributions which each science makes are always partial views, reached by processes of abstraction, by focusing attention on certain aspects of things." We need a more comprehensive view which allows a place for the feeling for nature and enables us to relate it to the whole of our activity.

Consequently, "the aim of this study of Animate Nature is to state the general results of biological inquiry which must be taken account of if we are to think of organic Nature as a whole and in relation to the rest of our experience. Both among careful thinkers and careless passers-by views of organic Nature are held in regard, for instance, to the organism as mechanism, the determinism of heredity, the struggle for existence. which seem to the author to be lacking in accuracy or in adequacy, which therefore tend to involve unnecessary difficulties in systematisation and perhaps gratuitous confusion in conduct. . . . While trying to keep wishes from fathering thoughts, we have been led in our study to see that the general results of Biology, when stated with accuracy, are not out of line with transcendental conclusions reached along other paths. . . . It looks as if Nature were much more conformable than is often supposed to religious interpretation, but we have not seen it to be our duty to justify the ways of God to man. We have tried to keep as close as possible to the facts of the case, leaving philosophical and religious inferences for those who are better qualified to draw them."

There is no attempt to reach transcendental results by the methods of science; but there is a persistent purpose in the lectures to show that there is nothing in science to interfere with a certain class of transcendental conclusions reached by other means. And the author does not hesitate to close his twentieth and last lecture, a remarkable one on "Vis Medicatrix Naturae" (The Healing Power of Nature), with the question: "Shall we not seek to worship Him whom Nature increasingly reveals, from whom all comes and by whom all lives?"

The first of the two volumes is devoted to the realm of organisms as it is, and the second to the evolution of the realm of organisms. The author is thoroughly convinced that the mechanistic interpretation of life is insufficient. He quotes with approval: "On the whole, there is no evidence of real progress towards a mechanistic explanation of life." He says: "The apsychic view is outrageous." "There has not yet been given any physico-chemical description of any total vital operation."

Biology seems justified in holding to the view that the evolutionary process gives rise to frequent outcrops of genuine novelties,

things not already necessarily implied in the past. "The outstanding fact about organic evolution is the increasing dominance of Mind." "Unless we have quite misunderstood evolution it implies an emergence of novelties. It is like original thinking." In it there is something like the joyous play of the organism at self expression. "It may be well for us, on our own behalf and for our children to ask whether we are making what we might of the well-springs of joy in the world; and whether we have begun to know what we ought to know regarding the Biology or the Psycho-biology of Joy."

Perhaps the most remarkable single matter in these lectures is the suggestion of a sort of cell-intelligence, particularly in the germ-cells. "Just as an intact organism from the Amoeba to the Elephant tries experiments, so the germ-cell, which is no ordinary cell, but an implicit organism, a condensed individuality, may make experiments in self-expression, which we call variations or mutations. Such, at least, is our present view of a great mystery." "The position we are suggesting is that the larger mutations, the big novelties, are expressions of the whole organism in its germ-cell phase of being, comparable to experiments in practical life, solutions of problems in intellectual life, or creations in artistic life." "The germ-cell is the blind artist whose many inventions are expressed, embodied, and exercised in the developed organism, the seeing artist who, beholding the work of the germ-cell, either pronounces it . . . to be good or . . . curses it effectively by sinking with it into extinction."

R. D. Carmichael
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SPECIAL ARTICLES

MORE LINKED GENES IN RABBITS

In Science for August 13, 1920, I presented evidence indicating the existence of linkage between the genes for English spotting and dilute pigmentation in rabbits. The evidence consisted of a group of 83 young produced in matings of a male heterozygous for both characters, mated with doubly recessive females. Such matings are expected to produce equal numbers of individuals of four color classes, if no linkage exists. Consistently, in his successive litters of offspring, this male sired more young in the non-cross-over classes than in the cross-over classes, which result indicated linkage of strength 23 on a scale of 100, the cross-over percentage being 38.5.

A second heterozygous male has since been tested, in similar matings with doubly recessive females, for the occurrence of linkage between the same pair of characters as seemed to be linked in the gametes of the first male, but shows *no linkage* with as much consistency as the first male showed linkage. The totals for the first male were 32 cross-over; 51 non-cross-over gametes; for the second male they are 75 : 76, as near equality as possible. The question now arises, Were the results given by the first male statistically significant? The cross-over percentage calculated as 38.5 has a probable error of 3.6 per cent. Hence the departure from 50 per cent. cross-overs (which would indicate *no* linkage) slightly exceeds three times the probable error, a result which would ordinarily be considered significant. Unfortunately no further experimental tests of this animal can now be made as he is no longer living. There can be no doubt about the negative result given by the second male. We are now confronted by this dilemma. Either the result given by the first male was *not* significant, or we may have in the same strain of rabbits two individuals, in one of which two characters show linkage, while in the other they do *not* show linkage. This latter alternative seems improbable, yet it can not be regarded as impossible on the chromosome hypothesis. Gates and Rees [1] in discussing the pollen development of *Lactuca sativa* state that the number of chromosome pairs in the species is nine but that

> Occasionally in diakinesis only eight chromosome bivalents were present, and frequently there were only seven or eight bodies present on the heterotypic spindle. This was found to be due to a tem-

[1] *Annals of Botany*, 35, 1921, p. 394.

porary end to end fusion of certain bivalents, usually the shorter ones, but occasionally the longest being involved. This phenomenon is also likely to disturb Mendelian ratios, causing partial linkage.

This last statement points out clearly the possibility of just such apparently irreconcilable results as we have obtained in the case of these two rabbits. If English spotting and dilution have their genes located in different chromosomes, the two characters will not ordinarily show linkage. If, however, these two chromosomes should form a temporary union with each other in the spermatogenesis of a male rabbit, linkage would result. Such linkage, however, would not be of the same nature as that found in *Drosophila*. Its strength would not be due to the distance apart of genes in a chromosome, but to the persistency of the temporary attachment between chromosomes ordinarily distinct.

The cytology of the rabbit is said to be difficult. Even the number of the chromosomes has not been definitely determined. According to the summary of Miss Harvey,[2] recent observers give the number as 11 or 12 pairs, but in older investigations the number is put at 14–18 pairs. One source of uncertainty as to the number may be the formation of temporary attachments between chromosomes such as Gates and Rees describe for *Lactuca*. While we await the outcome of the study of other cases, it seems reasonable to assume that the two characters, English spotting and dilution, have their genes located in distinct chromosomes, even though these may occasionally be united to such an extent as to produce partial linkage in the gametes of certain individuals.

This case shows the desirability of expressing linkage strength in terms of something less problematical than map-distances, since linkage may occur which varies quite independently of map-distance, as for example linkage between genes lying in different chromosomes. A method of expressing linkage strength on a scale of 100 has been suggested elsewhere.[3] By this method the linkage strength indicated among the gametes of the first rabbit was 23.0 ± 7.26, that for the second rabbit is 0.6 ± 2.7.

I have recently discovered in rabbits a case of linkage which is not doubtful, since it is found in the gametes of all rabbits so far studied, and in a strength which is beyond question statistically significant. This involves the same dominant character, English spotting, as was involved in the other case. It is strongly coupled with angora coat, a recessive character. The average linkage strength is over 80 on a scale of 100. Table I. summarizes the evidence for this case. In the production of the doubly heterozygous parents used in these test-matings, English and angora were derived one from the father, the other from the mother. Consequently the linkage here takes the form of "repulsion." The English young are regularly short-haired, the non-English young are regularly long-haired (angora), except in about one case in ten, when a crossover occurs.

TABLE I

Classes of Young Produced by Rabbits Doubly Heterozygous for English Spotting and Angora Coat, when Mated with Non-English Rabbits either Homozygous or Heterozygous for Angora Coat

Heterozygous English Parent	English Short	Non-English Angora	English Angora	Non-English Short	Per cent. Cross-overs
♂ 4595 (× hom. ♀♀)	25	25	2	1	5.6
" (× het. ♀♀)	18	14	3	1	11.1
♂ 4388 (× hom. ♀♀)	9	8	3	0	15.0
" (× het. ♀♀)	4	5	3	0	25.0
Het. ♀♀ (× hom. ♂♂)	16	17	0	1	2.9
Totals	72	69	11	3	9.0 ± 1.5
	Non-cross-overs		Cross-overs		

[2] *Jour. Morphol.*, 34, 1920.

[3] *Am. Nat.*, 54, May, 1920.

In order to increase the number of test matings, the males, 4,595 and 4,388, were mated with females which were merely *heterozygous* for angora coat, animals which were themselves short-haired but which had one parent an angora. Therefore only half the gametes of these females, viz., those which bore angora, would be useful in the test matings. Accordingly half the total young from such matings have been deducted before entering the totals in Table I., and of course the deductions have been made from the *short-haired* classes, equal numbers being deducted from the English and the non-English groups. Apparently male 4,595 gives a lower percentage of cross-overs than male 4,388, and the female double heterozygotes give a lower percentage than either male, but the totals are not large enough to give much weight to these ideas. The average result for all test matings is a cross-over percentage of 9.0 ± 1.5, which means linkage of strength 82 ± 3, on a scale of 100. This certainly is a significant result, which indicates that the characters English and angora have their genes in the same chromosome.

W. E. Castle

Bussey Institution,
December 1, 1921

THE HYDROGEN-ION CONCENTRATION OF CULTURES OF CONNECTIVE TISSUE FROM CHICK EMBRYOS

In view of the fact that tissue cultures in Locke-Lewis solution were to be used in observing the behavior of living cells when exposed to bacteria and other foreign substances, it became necessary to determine the optimum and the final hydrogen-ion concentration of the cultures themselves. For the purpose several hundred cultures of connective tissue of chick embryos were prepared, in Locke-Lewis solution with varying hydrogen-ion concentrations and containing different amounts of dextrose.

The normal solution was composed of 85 c.c. of Locke's solution ($NaCl$ 0.9 per cent. plus KCl 0.042 per cent. plus $CaCl_2$ 0.025 per cent. plus $NaHCO_3$ 0.02 per cent.), together with 15 c.c. of chicken bouillon and 0.5 per cent. dextrose. This solution has a hydrogen-ion concentration between 6.6 and 7, depending upon that of each lot of bouillon. For the experiments the hydrogen-ion concentration was varied from pH 4 to pH 9.2 with an increment of 0.2, and the amount of dextrose was varied from 5 per cent. to none at all.

The hydrogen-ion concentration of the cultures explanted into these solutions was determined at different stages of their growth, namely, when they failed to grow, when they exhibited extensive and healthy growth, and when they had degenerated after vigorous growth. This determination was made by a colorimetric method devised by Felton (1921) by means of which it is possible to test the small hanging drop of a culture.

Early in the investigation it was discovered that not all kinds of coverglasses were suitable for the experiments because of the change in hydrogen-ion concentration exhibited by control drops (without explant) when incubated upon this glass. It became necessary, therefore, to select coverglasses on which the control drop remained constant when incubated for a period of three weeks.

When cultures of embryonic chick tissue were prepared on reliable coverslips, those explanted into a medium with a hydrogen-ion concentration of 4 to 5.5 seldom showed any growth; those in a medium pH 5.5 exhibited growth in a few instances; while those in media having a hydrogen-ion concentration from pH 6 to pH 9 usually showed abundant growth. Approximately one hundred cultures were explanted into solutions pH 6, 7, 8, and 9. The percentage of growth which occurred in these cultures was respectively 71, 93, 89 and 81, while that of the normal cultures (pH 6.6–7) was 90 per cent. The optimum hydrogen-ion concentration seemed to be about pH 7.

When the hydrogen-ion concentration of these cultures was tested at different stages of their growth, it was noted that while it differed markedly, this was dependent much more upon the state of the culture at the time the test was made, and also upon the amount of dextrose in the medium, than upon the initial hydrogen-ion concentration of the medium.

Regardless of what the latter had been, cultures which contained healthy and extensive growth tended to be neutral, those which failed to grow had usually become slightly acid, and those that had exhibited extensive growth and then degenerated were most frequently slightly alkaline. These results, however, apply only to solutions containing not more than 0.5 per cent. dextrose, for when 1 per cent. or more dextrose was added to the medium the cultures were often found to be acid when death took place.

In these observations the optimum hydrogen-ion concentration for tissue cultures in Locke-Lewis solution was pH 7. The final concentration depended upon the amount of dextrose in the medium. Cultures in media containing no dextrose usually had a hydrogen-ion concentration ranging from 7 to 7.6; those in media having 0.25 to 0.5 per cent. dextrose ranged between pH 6 and pH 7.8, mostly pH 7.2 and pH 7.4; while those in media to which 3 per cent. and 5 per cent. dextrose had been added were often pH 6 and pH 5.6 respectively.

M. R. LEWIS,
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THE JOHNS HOPKINS MEDICAL SCHOOL

AN ELECTRICAL EFFECT OF THE AURORA

DURING the past year I have been making observations on the diurnal variation in electric potential difference between the earth, as represented by the water system of Palo Alto, and an uncharged, insulated conductor kept inside an earthed metal cage. The records of this variation have been registered continuously by a photographic method since July 20, 1920. For two weeks, or more, preceding the great aurora of May 14 these records were different from any which had preceded them, and two days before the beginning of the aurora there was a sudden change in the potential difference being measured which seemed to indicate an increase in the negative charge of the earth.

After the aurora the record of the diurnal variation was of a very different character from anything which had been obtained before. In Fig. 1, the continuous line represents the mean variation of the recorded potential-difference in millivolts for ten days preceding the aurora, and the broken line gives the same data for the ten days following the aurora. The mean daily range of the recorded potential difference on my record was 99.5 millimeters for the ten days preceding the aurora and 35.5 millimeters for the same period following the aurora.

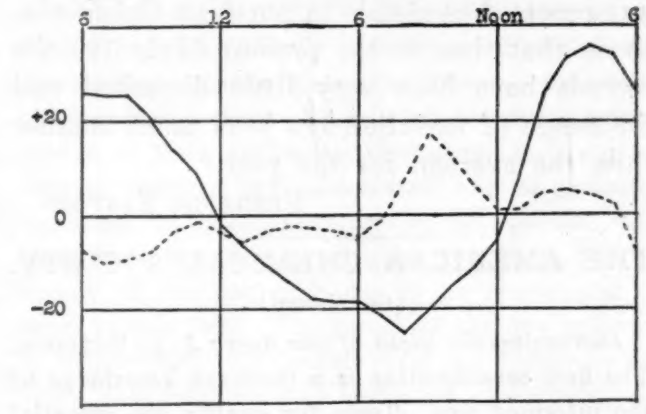

FIG. 1. Diurnal variation in potential difference between the earth and an uncharged, insulated conductor for ten days preceding and ten days following the aurora of May 14, 1921.

The mean diurnal variation in millivolts for the ten months, August, 1920, to May, 1921, is shown by the curve in Fig. 2.

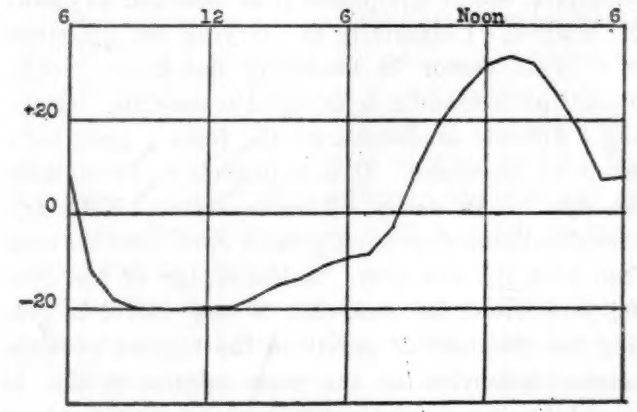

FIG. 2.

A simultaneous record of the change in the north component of the earth's magnetic field was made on the same sheet with the electrical record. For three days at the time of the aurora the magnetic record was too much disturbed to admit of measurement. The mean range of magnetic variation for

eight days preceding the aurora was 22.6 millimeters on my record; while for the five days after the record became measurable the mean diurnal variation was 17.7 millimeters.

During the entire month of June the electric records were more than usually disturbed. Early in July the disturbance increased. On July 6, 7 and 8 the disturbances were the greatest that have been observed since August 1, 1920. On the morning of July 10 an aurora was reported as visible in northern California. From that time to the present (July 19) the records have been very little disturbed and the range of variation has been much smaller than the average for the year.

Fernando Sanford

THE AMERICAN CHEMICAL SOCIETY.

(Continued)

Increasing the yield of our dyes: J. L. Bullock. The first consideration is a thorough knowledge of the intermediates. Tests for quality are essential as small amounts of impurity have a decided effect on the yield. Specialization on few dyes is necessary in order to know them thoroughly. The best intermediates obtainable are usually the cheapest in that they give greatly increased yields. The sedimentation of solutions is advantageous and filtration at every stage adds to tinctorial power of the subsequent dye. In actual synthesis of dyes, intelligent use of equipment is as essential as chemical control. Uniformity in carrying out reactions is a great factor in obtaining maximum yields. Diazotizations should be as rapid as possible. Coupling a difficult condensation; the foam a good indication of its course. It is important to precipitate the dye in an easily filterable state. With triphenylmethane dyes even greater care must be used than with the azo dyes. A knowledge of the dyeing properties, fastness, etc., is very useful in getting the standard of purity to the highest possible point. Attention to the most minute details is repaid by increased tinctorial power and lessened cost of the finished dye.

The preparation in the pure state of certain dyes of the malachite green series: Walter A. Jacobs and Michael Heidelberger. It is shown that in many cases in which the chlorides are too soluble or do not crystallize, the nitrates may advantageously be used for isolation of the dyes. Descriptions are given on this basis of salts of malachite green and some of its methyl, halogen, amino, acylamino, alkylamino, hydroxy, and alkoxy derivatives, as well as the nitrate of brilliant green, and the furfurol analog of malachite green.

The electrometric titration of azo dyes: D. O. Jones. The titanous chloride reduction methods originally suggested by Knecht for the analysis of numerous compounds, both organic and inorganic, have, in recent years, come into more general use in the field of dye chemistry. The titanous chloride method for the analysis of azo dyes becomes more generally applicable, when the end point of the titration is determined by the electrometric method. The method in general is similar to the usual oxidimetric analysis as carried out with the electrometric apparatus. In the former methods, employing the use of a sulphocyanide indicator, the end point in the back titration with ferric alum is sometimes difficult to determine. Dark colored material in suspension and the color which is sometimes imparted to the solution by the products of reduction do not interfere in the electrometric method. It also permits the use of larger samples, while the end point is readily and accurately obtained.

Extraction process of wool degreasing: Louis A. Olney. A thorough study of the subject of wool cleansing is quite sure to lead to the conclusion that the extraction method, *i.e.*, the treatment of the raw wool under proper conditions with certain organic solvents, is far more scientific in principle than the ordinary emulsive process. With efficient apparatus and good management the expense of cleansing wool is reduced to a minimum by this process and the results obtained approach the maximum established through theoretical and economical considerations. Although the early attempts to degrease wool by the use of volatile solvents resulted in complete failure, many practical incentives sufficed to keep interest in the process alive.

Fastness to storage: Oscar R. Flynn. Dyed cotton goods sometimes changes unevenly when stored in the folded piece. Regions of change mark out the channels along which air flows due to changes in temperature. This shows that the change in the dye is caused by some substance present in the air in small quantity and not primarily to oxidation, which shows its effect in the interior of a mass of goods. In some cases the change is temporary, and the result of the action of acid alone. In other cases the effect is due in the first place to acid, but followed later by complete destruction of the dye. Alkali sensitive dyes such as Stilbene Yellow show temporary changes due to acid alone. Acid sensitive dyes, such as

Congo Red, show permanent change due to fading after actions of acid. When alkalis are used in finishing, enough should be used to last a year or more. Alkali sensitive dyes should be finished in the acid condition. Dyes fast to acid and alkali are safest.

Relation of chemical structure to dyeing properties: Warren N. Watson.

Special cost features and their relation to the development of our organic chemical industry: Gaston DuBois.

The effect of dye structure on dye adsorption: Leon W. Parsons and W. A. McKim. Some preliminary results which were obtained during the course of an extended investigation now being conducted on the relation between the structure of dyes and their adsorption constants are discussed. Data have been obtained regarding the constants of adsorption in the case of the following water-soluble dyes when equilibrated with wool at constant temperature—picric acid, eosin, erythrosine, brilliant green, malachite green, ponceau 2G, ponceau 4GB, chromotrope 2R, and chromotrope 2B. In all cases, the equilibrium points obtained are found to be well represented by the Freundlich adsorption equation. A close similarity in structure between dyes within a certain chromophoric classification gives practically the same value for 1/n, one of the Freundlich constants, whereas a wider difference in structure is accompanied by a corresponding tendency toward divergence in the value of 1/n. Some interesting results have been obtained regarding the effect on adsorption of loading the pure dyes with various amounts of sodium sulfate.

Is an export trade necessary to the dye industry?: J. Merritt Matthews.

Preparation of amino-phenol-sulfonic acid by the chloro-benzene method: Joseph R. Minevitch. Amino-phenol-sulfonic acid (2: 1: 4) is best prepared by reducing the corresponding nitro-phenol-sulfonic acid with either acid or alkali reducing agents, depending upon the medium in which the nitro body is last obtained. A successful manufacturing process would, therefore, largely be based upon the ease with and small cost at which the nitro compound can be produced in large quantities. There are four other possible methods for its manufacture but the chloro-benzene process gives the highest yield and at a vastly cheaper cost. The paper will consist of a discussion of experimental results and will give directions for preparation.

The future of research in the dye industry: M. L. Crossley. Research is of vital importance to the dye industry. Men must be carefully selected and thoroughly trained. It is of the utmost importance that only those giving promise of research ability and possessing the capacity for the development of the spirit of research should be selected. To depend upon "the law of the survival of the fittest" to eliminate the unfit is economically wasteful and dangerous. A grave responsibility rests upon our educational institutions for the selection and training of men to direct and carry on the future activities of our industries. The training for research must be thorough. Herein, our system of education is weak. There must be greater appreciation of the contribution of research to the progress of industry before research will be correctly evaluated. The compensation of the research man must be commensurate with his service to the industry, if the best men are to be encouraged to serve in this field. The future of the dye industry in this country will depend upon our ability to develop able research men and upon our willingness to adequately appreciate the contribution of research to the progress of the industry.

The qualitative and quantitative evaluation of dyestuffs: Robert E. Rose. Determining the value of dyestuffs is an art as complex as that of the gem expert. The dye tester must compare different colors so closely that he is able to tell the difference produced by 1/32 of an ounce of color in 1000 lbs. of material. He must do this on a little sample, weighing 1/14 to 1/3 oz., that is, he actually sees the difference produced by adding or subtracting 1/10,000,000 of an ounce of the dyestuffs in the field of vision. In the matter of shade he must check one lot of dye against another and not pass any two that vary perceptibly to the ordinary eye. If he is asked to do so, he must be ready to match colors just as exactly.

A method for the use of metal sensitive chrome colors in iron machines: Francis C. Telen.

The present status of the domestic coal-tar product industry: C. R. de Long.

DIVISION OF WATER, SEWAGE AND SANITATION

W. P. Mason, Chairman
W. W. Skinner, Secretary

Investigations of the chemical reactions in water purification, using the hydrogen electrode: A. M. Buswell. Titration curves with carbonates of sodium, magnesium and calcium, using a strong acid, show that the shape and position of the curve is

unaffected by the metal ion, but that the inflection point occurs at a slightly lower hydrogen-ion concentration in dilute solutions than in the more concentrated ones. Precipitation curves of the precipitation of calcium as the carbonate while not as regular as those obtained in the precipitation of magnesium, tend to show that the reaction is complete, sufficient carbonate being present, at a hydrogen-ion concentration corresponding to pH of 9.5.

Study of the Weszelszky method for the determination of iodide and bromide: W. E. Shaefer and J. W. Sale. The Weszelszky method has been carefully tested. The kind and quantity of absorbing alkali and the time and temperature used to remove the chlorate were varied until satisfactory conditions for the recovery of bromine from bromine water were found. A modified absorption apparatus was constructed and the kind and concentration of the acid added to the reaction flask varied in an effort to recover bromine quantitatively from potassium bromide and estimate it by the method found to be satisfactory. Iodine was converted into iodic acid by chlorine water in the reaction flask and estimated in solutions of various acid concentrations. A rapid and satisfactory modified Weszelszky method for the determination of small amounts of iodine based on these experiments is given. The Weszelszky method for bromide in the presence of iodide, however modified, is incapable of giving satisfactory results on small samples and its use is not recommended.

Purity of bottled mineral waters: W. W. Skinner and J. W. Sale. During the past year, the Water and Beverage Laboratory of the Bureau of Chemistry has made sanitary inspections of about seventy-five springs and wells, located in ten states. These inspectors uncovered numerous unsuspected sources of pollution of which specific examples are described. Samples of water from interstate shipments and from shipments offered for entry into the U. S. are also analyzed for their purity. In the last six years over 4,000 bottles were opened and the water examined. Shipments of polluted water are either refused entry in the case of foreign waters or are condensed and destroyed in the case of domestic waters.

Commercial peptones and the culture media used in the examination of water: E. M. Chamot and F. R. Georgia. Titration curves of the following peptones are shown: Witte; Bacto (Digestive Ferments Company); Proteose (Digestive Ferments Company); Armour's; Parke, Davis Company; Fairchild Brothers and Foster; and Stearns. The peptones are grouped according to relations shown by these curves. The optimum reaction (P_H) using a culture of *B. coli* is given for each peptone. This is determined by attenuating the culture by exposure to a suitable dilution of phenol and inoculating a series of tubes containing the peptone solution adjusted to various P_H values at definite time intervals and noting the P_H value in which growth is obtained after exposure of the culture to the phenol for the longest period of time. It is shown that Witte, Bacto, Proteose, Armour's, and Parke, Davis and Company Peptones give optimum growth when unadjusted or but very slightly adjusted. With Fairchild Brothers and Foster's and Stearns's peptones it is necessary to adjust the reaction to a P_H value slightly above 5.7. It is shown that the optimum P_H value for *B. coli* in peptone KCl solution varies over a considerable range and depends on the peptone used. The introduction of lactose into the medium changes the optimum P_H value.

A study of the activated sludge process: J. A. Wilson, W. R. Copeland and H. M. Heisig.

Mineral composition of the water supply of seventy cities in the United States: J. W. Sale and W. W. Skinner. The paper develops the fact that statistics showing the mineral composition of the water supplies of even the larger cities in the United States have not been compiled heretofore, although the matter is of considerable interest particularly to physicians and to the traveling public. Seventy analyses obtained from city officials have been reduced to a common basis for comparison and tabulated. Of the cities mentioned, Atlanta, Ga., has a water supply which contains the smallest amount of dissolved mineral matter, while Oklahoma City, Okla., has a water supply which contains the largest amount of dissolved mineral matter.

Quantitative versus qualitative adjustment of the H-ion concentration of culture media: Geo. C. Bunker and Henry Schuber. The reactions of culture media prepared in the laboratories of waterworks are determined by one of the following three methods, of which the first two may be classed as loose and the third as approximate in reference to their precision. (1) By titration with phenolphthalein, (2) with phenol red or with brom thymol blue and (3) by comparison of a portion of the medium, to which a suitable indicator has been added, with color standards of definite H-ion concentration. The methods are discussed.

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